

Air-to-air missile. In production and service.

Prime contractor: British Aerospace Dynamics Group
Guidance and Control: Semi-active radar homing
Length: 12ft (3.66m)
Max body diameter: 8in (0.203m)
Wing span: 3ft 4.25in (1.02m)
Launch weight: 425lb (193kg)
Cruising speed: Mach 4
Max range: 31 miles (50km)

Development and Service

Sky Flash (XJ521) is a medium-range all-weather missile based on the American Raytheon AIM-7E Sparrow. It is a 'boost and coast' missile, with a new semi-active radar homing head designed by Marconi

Space and Defence Systems Ltd, for all-sector attack against subsonic and supersonic aircraft, flying faster and higher or lower than the launch aircraft. It can be launched at subsonic or supersonic speeds and is fitted with a new fuse system developed by EMI Electronics Ltd, which helps to give it a high single-shot kill capacity against targets at any altitude. Full development and initial production were covered by Ministry of Defence contract in February 1974. The first five firings, in 1975-76, proved highly successful, even against 'glinting' jet targets. Firing trials were completed in December 1977. Sky Flash missiles will eventually arm RAF Panavia Tornado F Mk 2s, and have been ordered by the Swedish Air Force for its Saab JA 37 Viggen under the designation RB71. Successful launches have also been made from the General Dynamics F-16 fighter.

SLAM

Ship-launched missile system. In service.

Prime contractor: Vickers Ltd, Shipbuilding Group

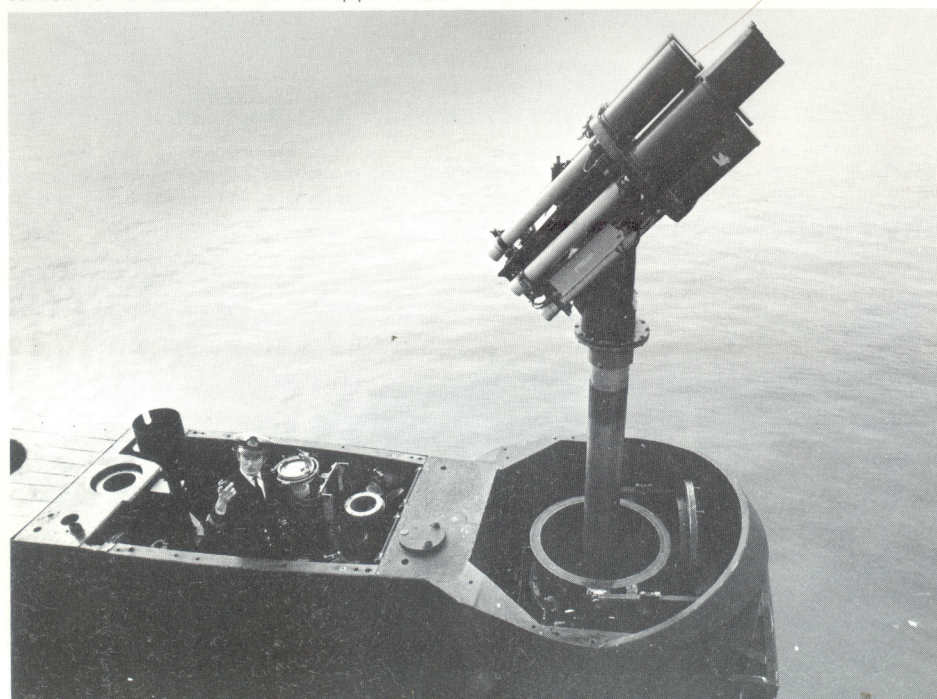
Development and Service

The acronym SLAM signifies surface-launched air missile system. In its initial form, the weapon system was originally developed for compatibility with the Oberon class of submarines; but SLAM can be retro-fitted or built into almost any type of underwater or light surface craft for short-range defence against aircraft, helicopters and enemy surface craft. It consists of a cluster of six Blowpipe missile

launchers surrounding an electronic package on a pylon mounting. Equipment in the electronic package includes a TV camera, gyro-stabiliser and some missile control equipment. After launch, each missile is guided by joystick by an operator in the ship's control room, who keeps both missile and target centred on a TV monitor. Preliminary trials of SLAM had been completed by January 1970. Sea trials on the submarine *Aeneas* were successfully completed by the end of 1972. The three Vickers Type 206 submarines of the Israeli Navy have provision for SLAM.

Below: SLAM installation on board HMS *Aeneas*.

UK



Snapper (AT-1)

Light anti-tank missile. In service.

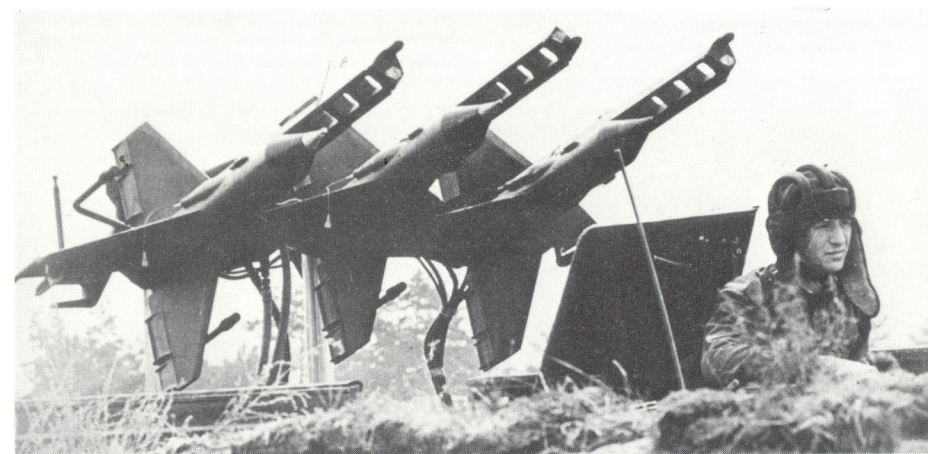
Powered by: Solid-propellant rocket motor
Airframe: Short cylindrical body with conical nose-cone. Rear-mounted cruciform wings of delta shape, each with one or two vibrating spoilers mounted in its trailing-edge
Guidance and Control: Wire-guided and spin-stabilised. Control by means of spoilers
Warhead: Hollow charge, weighing 11.5lb (5.25kg), with contact fuse. Capable of penetrating 13.7in (35cm) of armour
Length: 3ft 8.5in (1.13m)
Body diameter: 5.5in (0.14m)
Wing span: 2ft 5.5in (0.75m)
Launch weight: 49lb (22.25kg)
Cruising speed: 120mph (323km/h)
Range: 1,640-6,560ft (500-2,000m)

Development and Service

Like 'Guideline' and 'Atoll', this is one of the better-known Soviet missiles because examples were

captured by the Israeli Army during the 1967 June War. 'Snapper' is a first-generation anti-tank weapon, similar in configuration to Western missiles such as the Nord SS.10 and MBB Cobra. In its initial operational form, as captured by Israel, 'Snapper' was carried on a quadruple launcher by a GAZ-69 jeep-type vehicle. Control was by joystick, and the operator kept the missile aligned on target during flight with the aid of tracking flares mounted on two of the wings. Standard transport/launch vehicle in recent years has been the armoured, amphibious BRDM, which carries a retractable three-round launcher. Although old and being replaced by the 'Sagger' missile, 'Snapper' continues to serve with the Warsaw Pact countries and with Afghanistan, Egypt, Mongolia, Syria and Yugoslavia.

Below: 'Snapper'.



Spada

Short-range surface-to-air missile system. Under development.

Prime contractor: Selenia Industrie Elettroniche Associate SpA

Development and Service

Spada is an all-weather, quick-reaction missile system designed for point and area defence against low and very low-altitude formations of aircraft or sequential attack. It consists of Aspide missiles, a 4-cell missile launcher, tracking and illuminating radar, search and interrogation radar and control

unit. All elements of this system are air and ground transportable. Spada is in an advanced phase of development. A land mobile Spada system is also under development and comprises three vehicles; a search and tactical control unit, a fire control and guidance unit and a launch unit with an eight-cell Aspide missile launcher.

USSR

Italy

Sparrow (AIM-7)

Long-range air-to-air missile. In production and service.

Data: AIM-7F

Prime contractor: Raytheon Company

Powered by: Hercules Mark 58 Mod 0 solid-propellant rocket motor

Airframe: Slim cylindrical body with pointed ogival nose. Pivoted cruciform delta wings mid-way along body, indexed in line with cruciform delta tail-fins

Guidance and Control: Raytheon semi-active Doppler radar homing system. Control by movable wings

Warhead: High-explosive continuous-rod warhead, weighing 88lb (40kg), actuated by proximity or contact fuse

Length: 12ft 0in (3.66m)

Body diameter: 8in (0.20m)

Wing span: 3ft 4in (1.02m)

Launch weight: 500lb (227kg)

Max speed: over Mach 3.5

Max range: 28 miles (44km)

Development and Service

Sparrow is one of the most important missiles currently in service with the NATO air forces, their allies and friends. It is a large, all-weather all-altitude weapon, of which up to four can be carried by the McDonnell Douglas F-4 Phantom IIs of the USAF, US Navy, US Marine Corps, RAF, Royal Navy and other air forces. The Lockheed F-104S Starfighters of the

Italian Air Force each carry two Sparrows, and similar weapons arm the McDonnell Douglas F-15 Eagle and Grumman F-14 Tomcat, America's primary fighters. Mitsubishi is producing more than 600 in Japan, for aircraft of the Japan Air Self-Defence Force, and a version known as Sky Flash is in production by British Aerospace for the RAF.

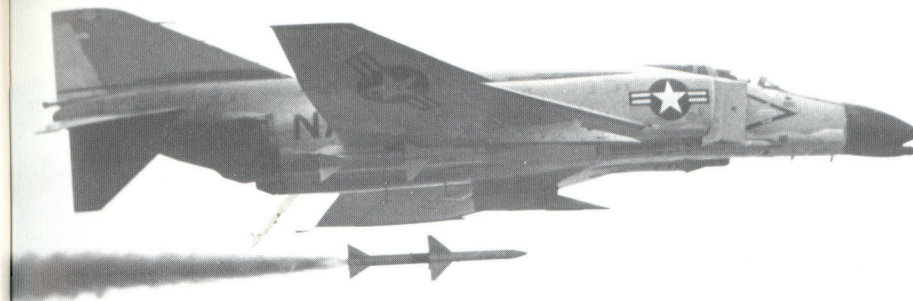
The basic current version of Sparrow is the AIM-7F, an advanced model with improved manoeuvrability, making it an efficient 'dogfight' weapon as well as a good medium-range missile with all-aspect capability. It has many new features, including a Hercules rocket motor of larger size than the Rocketdyne Mk 38 Mod 2 fitted to earlier versions, a new Doppler guidance system with smaller solid-state seeker, and a heavier repositioned warhead.

A total of 34,000 AIM-7C, D and E Sparrows was built. General Dynamics and Raytheon are expected to produce 9,804 AIM-7Fs for the US Navy and 9,150 for the USAF. By 1981, it is hoped to equip these missiles with a new monopulse seeker to enhance lookdown performance and provide improved resistance to clutter and ECM. Ship-launched adaptations of Sparrow are described under the Sea Sparrow entry.

Below: Sparrow (lower) and Sidewinder (above) with nosecon.

Top right: Sparrow launch from a F-4 Phantom II.

USA



Spartan (XLIM-49A)

Long-range anti-ballistic missile. Deactivated and put in store in 1976.

Prime contractor: Western Electric Company Inc

Warhead: Thermonuclear

Slant range: approx 465 miles (750km)

Development and Service

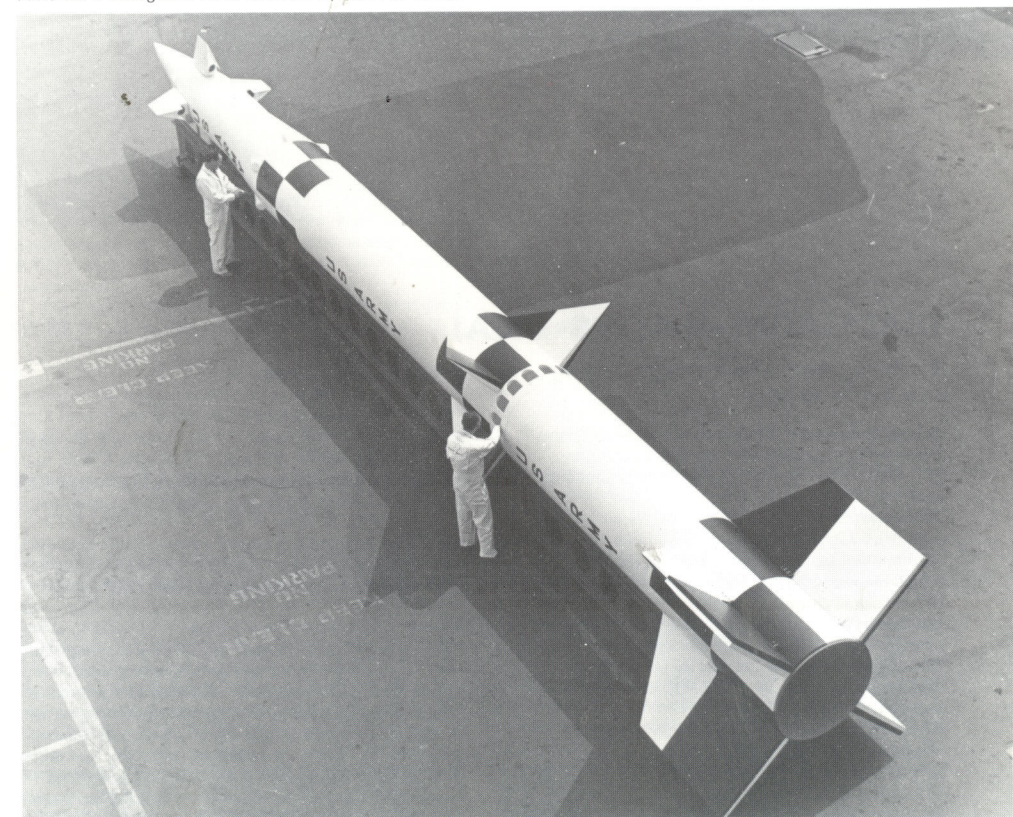
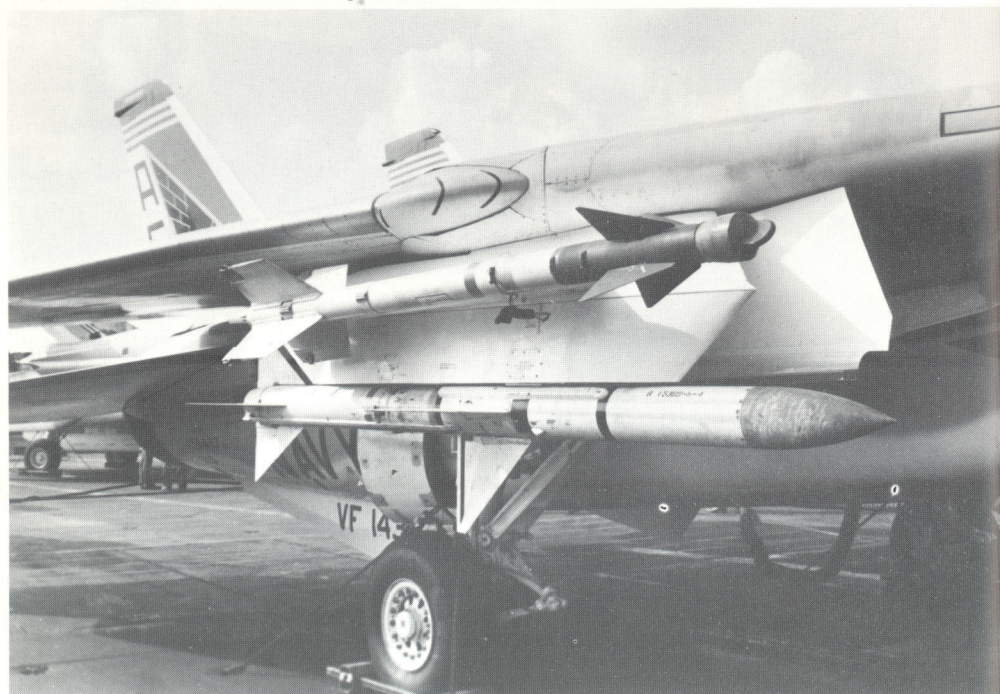
Spartan was the long-range partner to Sprint in America's Safeguard ABM defence system, of which

only the Perimeter Acquisition Radar (PAR) remains functional, which was built to provide initial track data to alert firing units.

An improved Spartan has been studied, as a higher performance missile with a quicker reaction time, making it suitable for use against depressed trajectory ICBMs and low-altitude SLBMs, and with 'loiter' capability.

Below: Full-size mock-up of Spartan.

USA



Sparviero

Anti-tank missile. Under development.

Prime contractor: Breda Meccanica, Bresciana SpA
Powered by: Solid-propellant rocket motor
Airframe: Cylindrical body with rounded nose. Cruciform flip-out foreplanes and tail-fins
Guidance and Control: Infra-red guidance system developed by Officine Galileo
Warhead: Hollow charge, weighing 8.8lb (4kg)
Length: 4ft 6.25in (1.38m)
Body diameter: 5.1in (0.13m)
Span: 1ft 9in (0.53m)

Sprint

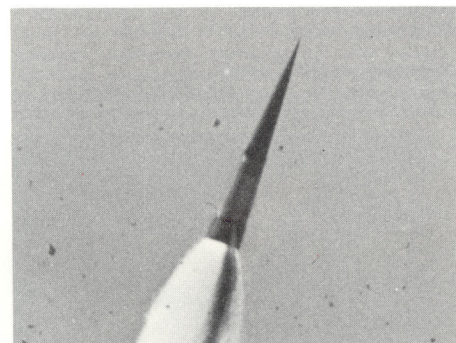
Close-range anti-ballistic missile. Deactivated and put in store in 1976.

Prime contractor: Martin Marietta Corporation
Warhead: Nuclear
Range: approx 25 miles (40km)

Development and Service

This close-range weapon was developed to provide a 'last-ditch' defence against enemy ICBMs which eluded Spartans in America's Safeguard Ballistic Missile Defence (BMD) system. An improved version of Sprint, 'Sprint II', was also developed.

ABM research and development are continuing in the USA, despite the deactivation of the Safeguard system.



Weight of missile: 36.4lb (16.5kg)
Weight of system: 152lb (69kg)
Range: 250-9,850ft (75-3,000m)

Development and Service

The tube-launched Sparviero (Hawk) is a third generation anti-tank missile, being developed for the 1980s. It also has surface-to-surface and air-to-surface (helicopter-launched) capabilities. It is reported to be the first missile of its type to do away with trailing wires for transmission of guidance command signals.

Italy

USA

SRAM (AGM-69A; WS-140A)

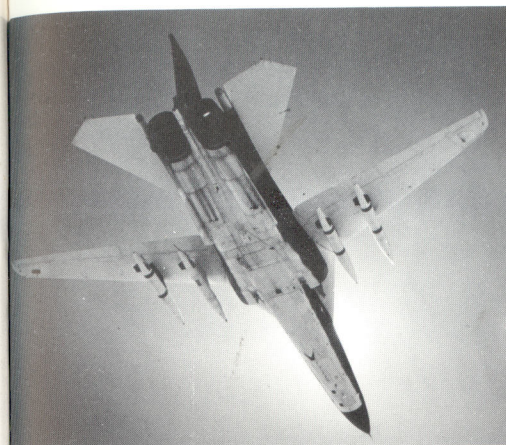
Air-to-surface short-range attack missile. In service.

Prime contractor: Boeing Aerospace Company
Powered by: Lockheed Propulsion Company LPC-415 restartable two-pulse solid-propellant rocket motor
Airframe: Body of circular section, tapering at tail and fitted with long ogival pointed nose-cone. Three equi-spaced tail control surfaces around nozzle, which is faired off by a destructible tail-cone when the missile is carried externally
Guidance and Control: KT-70 inertial guidance system, with terrain avoidance capability, by Kearfott Division of Singer Co. Control by tail surfaces
Warhead: Nuclear, W-69 of 200 kiloton yield
Length: 14ft 0in (4.27m)
Body diameter: 1ft 5.5in (0.445m)
Weight: approx 2,230lb (1,010kg)
Cruising speed: over Mach 3
Max range: 100 miles (160km) in 'high mode' 35 miles (55km) in 'low mode'

Development and Service

Boeing started work on a short-range attack missile (SRAM), to extend the effective life of the B-52G and H versions of their Stratofortress strategic bomber, in December 1963. By July 1965, the USAF had formulated a need for a weapon of this type; after studying tenders from five competing companies, they selected Boeing as prime contractor for the AGM-69A (Weapon System 140A). Each B-52G/H can carry 20 SRAMs, of which 12 are mounted as three-round underwing clusters and eight go on a rotary launcher in the aft bomb-bay, together with four Mk 28 thermonuclear weapons. The swing-wing FB-111As of two Strategic Air Command wings can each carry six SRAMs, four on swivelling underwing pylons and two internally. Development launches from both types of aircraft began in 1969. In one test by a USAF crew from a B-52 in 1970, two missiles launched in rapid succession hit two separate targets. Production was authorised by the USAF in January 1971, and deployment to B-52 units began on 4 August 1972. SRAM was also expected to arm

USA

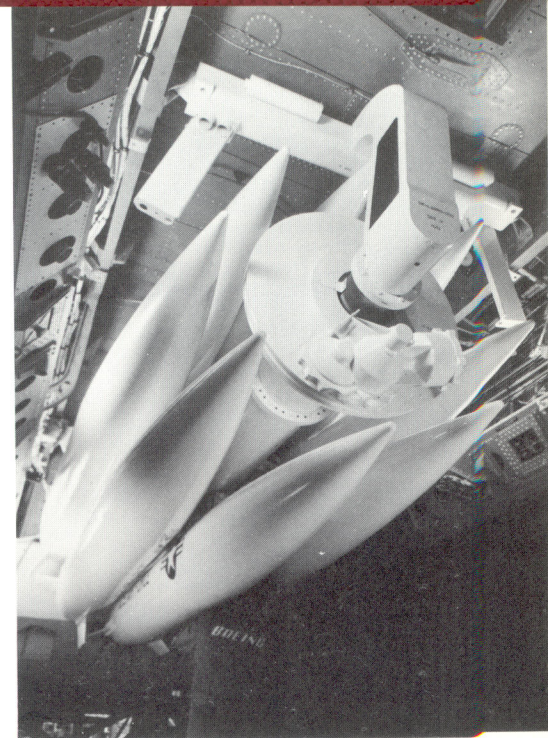


the Rockwell International B-1 supersonic bomber until it was cancelled in 1977.

Key to the accuracy of SRAM is the information fed into its guidance system before launch. The Guidance and Controls Division of Litton Industries is responsible for the B-52 inertial measurement unit; Autonetics Division of Rockwell International for the B-52/FB-111 aeroplane computer; IBM for modifying the B-52 bomb-nav system. The missile can fly 'dog-leg' courses to elude the defences, is unaffected by enemy ECM and appears no larger than a machine-gun bullet on radar screens. Its range is said to vary from 100 miles (160km) at high altitude to 35 miles (55km) at low level, at high supersonic speed.

All 1,500 SRAMs ordered had been delivered by August 1975 to the 18 Strategic Air Command bases scheduled to receive the missile, equipping 17 B-52 and 2 FB-111A wings. About 1,400 remain operational.

The improved AGM-69B SRAM-B was cancelled in 1977 after the Rockwell International B-1



Above left: SRAMs under the wings of an FB-111A.

Above: SRAM eight-round rotary launcher.

strategic bomber programme was abandoned, which was expected to be the carrier aircraft. However, SRAM-As are to be upgraded using a new Thiokol rocket motor and improved electronics including alterations to the computer to increase the missile's flight profile capability.

SS.11

Surface-to-surface battlefield missile. In production and service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques
Powered by: Two-stage solid-propellant rocket motor
Airframe: Cylindrical body, with sweptback cruciform wings and rounded ogival nose
Guidance and Control: Wire guidance by line-of-sight command via operator's joystick controller. Spin-stabilised. Control by deflection of the sustainer efflux
Warhead: Alternative Type 140 AC armour-piercing able to penetrate 24in (600mm) of steel, Type 140 APO2 high-explosive which will penetrate 0.4in

France

(10mm) of steel plate at full range, or Type 140 AP59 high-fragmentation anti-personnel type with contact fuse. Inert type for practice available
Length: 3ft 11in (1.20m)
Body diameter: 6.5in (0.164m)
Wing span: 1ft 7.5in (0.50m)
Launch weight: 66lb (29.9kg)
Cruising speed: 360mph (580km/h)
Range limits: 1,650-9,840ft (500-3,000m)

Development and Service

Nord-Aviation developed this very effective tactical missile as a follow-on to its success with the SS.10 and Entac. Production has been continued by Aérospatiale. It is used by all three French services and by the armed forces of 20 other countries including the USA and UK.

Being larger than the SS.10, the SS.11 is fired normally from ground vehicles and light naval vessels, including hovercraft; but it can be dismounted for operation from a ground launcher by mountain combat, airborne and coastal defence forces. In action, the operator follows both the target and the missile by means of a magnifying optical sight, and guides the missile to impact by means of a control joystick. Tracking is facilitated by flares on the rear of the missile. When the missile is installed on a ship a special stabilised sight is used. The standard production version since 1962 has been the SS.11 B.1 (and AS.11 B.1) with transistorised firing equipment. The Harpon is similar except for its use of TCA guidance. (See AS.11 for production totals).

Right: SS.11s on a jeep launcher.

Below: SS.11 launch.



SS.12

Surface-to-surface tactical missile. In service.

Prime contractor: Nord-Aviation/Aérospatiale, Division Engins Tactiques

Powered by: Two-stage solid-propellant rocket motor

Airframe: Cylindrical body with mid-positioned cruciform wings and bulged ogival nose. Two sustainer nozzles aft of wings, on opposite sides of body

Guidance and Control: Wire-guided by command line-of-sight. Manual infra-red missile tracking. Spin-stabilised. Control by sustainer jet deflection

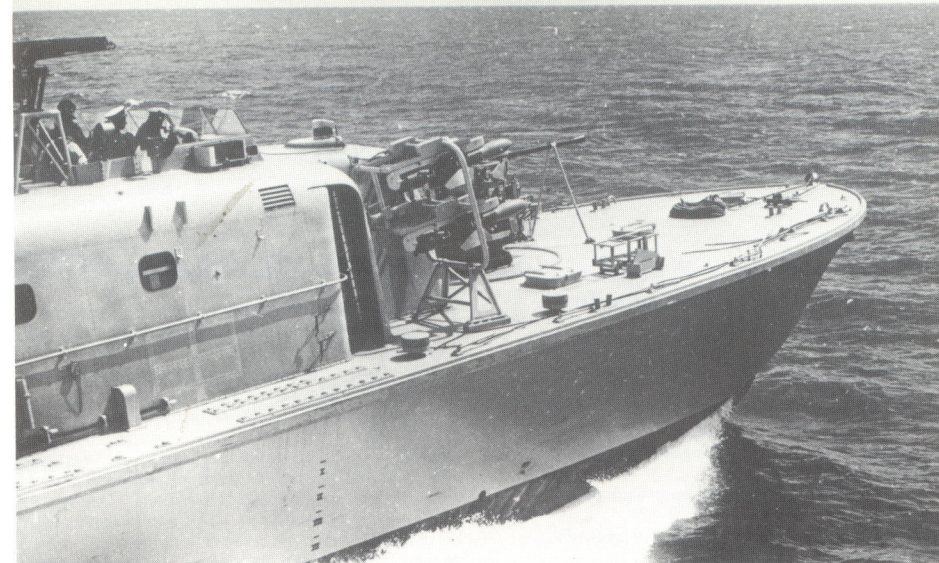
Warhead: Alternative OP.3C armour-piercing warhead capable of penetrating more than 1.5in (40mm) of steel, shaped charge for anti-tank use, or pre-fragmented anti-personnel type, each weighing 66lb (30kg)

Length: 6ft 1.9in (1.87m)
Body diameter: 7in (0.18m)
Wing span: 2ft 1.5in (0.65m)
Launch weight: 167lb (75kg)
Cruising speed: 425mph (685km/h)
Max range: 19,650ft (6,000m)

Development and Service

By scaling up their very successful SS.11 Nord-Aviation (now Aérospatiale) were able to produce the still-compact SS.12 with a warhead about four times as heavy as that of the smaller missile. This makes it suitable for use against fortifications as well as all types of vehicles, including tanks and ships. The missile uses optical line-of-sight command guidance, through trailing wires. Another derivative is the 'marine' SS-12M, which was first demonstrated to naval officers of eight countries from the coastal patrol boat *La Combattante*, off

France



Toulon, on 15 June 1966. On that occasion, two SS.12Ms were fired from a lightweight launcher, with self-contained optical sighting, guidance and control equipment, against a moving target nearly 3.5 miles (5.5km) away. Both impacted the target within 3ft (1m) of dead centre and the same distance above the waterline. First operational fast patrol boats to be fitted with this weapon were three

Above: Susa class patrol boat carrying SS.12M missiles.

Vosper Thornycroft Susa class patrol boats of the Libyan Navy. Each carries two four-round launchers able to mount SS.12Ms for combat use or SS.11s for training. Orders for 8,287 AS.12/SS.12 missiles had been received by January 1979.

SS-16

Intercontinental ballistic missile. In service.

Powered by: Solid-propellant motor

Airframe: Three-stage missile

Guidance and Control: Inertial

Warhead: Probably of more than one megaton yield. MIRV capability

Length: 65ft 8in (20m)

Range: More than 5,000 miles (8,000km)

USSR

Development and Service

SS-16s were expected to replace the SS-13s deployed, although it has been reported that deployment has not yet been undertaken. This missile uses an advanced navigation guidance system and a computer-operated post-boost vehicle but it is believed that initial deployment was planned only with a single re-entry vehicle. A land-mobile version could also be available. Test firings began in 1972.

SS-17

Intercontinental ballistic missile. In production and service.

Powered by: Liquid-propellant motors

Airframe: Two-stage missile

Guidance and control: Inertial

Warhead: MIRV version with four warheads of up to one megaton each. Mod 2 version has single large warhead

Length: approx 78ft 9in (24m)

Body diameter: approx 8ft 2in (2.5m)

USSR

Range: estimated at over 6,200 miles (10,000km)

Development and Service

Successor to the SS-11 (along with the SS-19), this missile has a far greater throw weight than the older missile and improved survivability. It has been tested with a single large re-entry vehicle and with four MIRVs. The single re-entry vehicle, with the accuracy given by the post-boost vehicle, permits operation against hard targets. It is uncertain whether operation with the MIRVs is sufficiently accurate to

destroy hard targets. This missile employs high-speed re-entry vehicles, and guidance refinement may confer a counter-force capability. The MIRVed SS-17 became operational in 1975. It is 'cold launched', being popped out of its silo by a gas generator before

SS-18

Intercontinental ballistic missile. In production and service.

Powered by: Liquid-propellant rocket motor
Airframe: Two-stage missile
Guidance and Control: Inertial guidance. Control probably by gimballed nozzles
Warhead: Mod 1 has single re-entry vehicle of 25-50 megaton yield
 Mod 2 has eight MIRVed warheads each of 1-2 megaton yield
 Mod 3 has single re-entry vehicle with greater accuracy
Length: approx 118ft 2in (36m)
Body diameter: approx 9ft 10in (3m)
Range: approx 7,450 miles (12,000km)

SS-19

Intercontinental ballistic missile. In production and service.

Powered by: Liquid-propellant motor
Airframe: Two-stage missile
Guidance and Control: Inertial guidance. Control probably by gimballed nozzles
Warhead: Mod 1 has six MIRVed warheads each with one megaton yield
 Mod 2 has been tested with single re-entry vehicle
Length: approx 88ft 7in (27m)
Body diameter: approx 9ft (2.75m)
Range: 6,200 miles (10,000km)

Development and Service

This 'hot-launched' missile is, with SS-17, replacing the SS-11 ICBMs, and about 300 SS-19s were thought to be deployed by 1979, mostly if not all

SS-20

Mobile intermediate-range ballistic missile. In service.

Powered by: Solid-propellant motors
Airframe: Two-stage missile
Guidance and Control: Inertial guidance. Control possibly by fluid injection into nozzle

its first-stage motors are fired. This reduces damage to the silo, permitting reload. At least 100 were thought to be deployed by 1979, most with MIRVed capability.

Development and Service

Designed to replace the SS-9, this missile has 30-50% greater throw weight than the SS-9 and is the largest of the new Soviet ICBMs. It has been tested in Mod 1 and Mod 3 forms with a single large re-entry vehicle and in Mod 2 form with a bus-type system with eight large MIRVs. It has a hard-target capability even when MIRVed and was deployed initially in 1974 in Mod 1 form in large new silos as well as in modified SS-9 positions. The Mod 2 version entered service in 1976 and is expected to be deployed most widely in due course. The Mod 3 version also entered service in 1976 and has a greater range than the earlier Mods. More than 200 SS-19s were deployed by 1979. During a test launch in 1974, an SS-18 travelled 5,800 miles (9,330km). It is 'cold launched' like the SS-17.

with Mod 1 warheads. High-speed re-entry vehicles are employed and an uprated guidance is used. Test launches are thought to have started in 1973. The SS-19 became operational in 1975.

The SS-19 is reported to pose a serious threat to the survivability of the USA's Minuteman force. It has been reported that Congressional studies have indicated that a mere 15% of Soviet ICBMs could put out of action upwards of 75% of American missiles mainly due to the standard of Soviet guidance systems and their huge warheads. In contrast, current American missiles are reported to be capable of only a limited success against Soviet missile sites.

Warhead: Three MIRVs each of 600 kiloton yield
Length: 52ft 6in (16m)
Body diameter: approx 5ft 9in (1.75m)
Range: at least 3,420 miles (5,500km)

Development and Service

The SS-20 utilises the first two stages of the SS-16

USSR

USSR

USSR

ICBM and has a MIRVed payload. It is therefore far more formidable than the 'Sandal' and 'Skean' missiles it is replacing and poses an increased throw-weight that faces Western Europe. It is a mobile system launched from a tracked vehicle with reload

SS-21 and SS-22

Surface-to-surface bombardment missiles. In production and service.

Development and Service

These are two new guided battlefield missiles. Both are already in service with the Soviet forces and possibly other Warsaw Pact nations. SS-21s are expected to supplement 'Frog' missiles and later

capability. It has been reported that as many as 400 SS-20 launch vehicles, with a higher number of missiles (and reloads) are expected to be deployed initially. About 100 are already operational.

supersede them. The SS-22 will supersede the 'Scaleboard' missile system. It is thought to be suitable for nuclear, chemical and conventional warheads, and a range of 500 miles (805km) has been reported. It has also been said that SS-22 is intended for conventional attacks on hardened aircraft shelters.

SS-X-?s

Intercontinental ballistic missiles. Under development.

Development and Service

It has been reported that four new ICBMs are currently under development in the Soviet Union for possible deployment in the mid-1980s. No further information is available.

SSBS (S-2)

Surface-to-surface ballistic missile. In service.

Prime contractor: Aérospatiale Division des Systèmes Balistiques et Spatiaux
Powered by: First stage SEP P.16 (Norma Type 902) solid-propellant motor
 Second stage SEP P.10 (Norma Type 903) solid-propellant motor
Airframe: Two-stage missile. Cylindrical body of constant diameter, with basically cylindrical re-entry

vehicle of smaller diameter
 1st stage casing of maraging metal
 2nd stage casing of Vascojet 1000. Cruciform tail-fins
Guidance and Control: Inertial guidance system. Each stage has four gimballed nozzles for control
Warhead: Nuclear, 150-kiloton yield
Length: 48ft 6.5in (14.80m)
Max body diameter: 4ft 11in (1.50m)
Launch weight: 70,327lb (31,900kg)
Max range: 1,960 miles (3,150km)

USSR

USSR

France



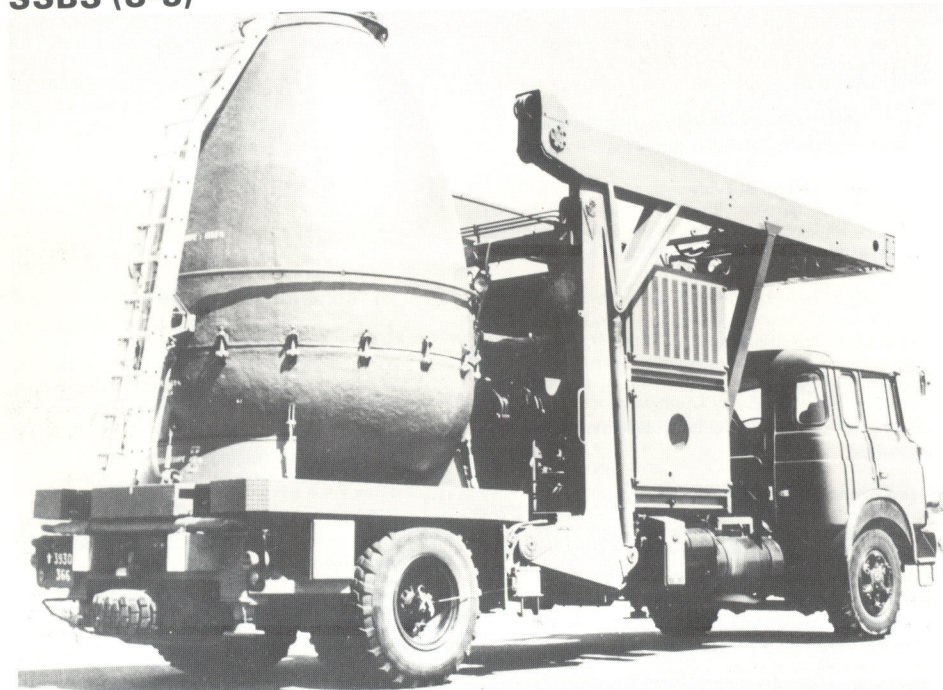
Development and Service

Two operational squadrons of the 1er Groupement de Missiles Stratégiques of the French Air Force deploy a total of 18 SSBS (sol-sol balistique stratégique) missiles. These are housed in underground silos on the Plateau d'Albion, east of Avignon in Haute Province, with fire control centres at Rustrel (Vaucluse) and Reilhannette (Drôme). The Saint-Christol Air Base (Apt) provides operational command, and technical and logistical support. The missiles are held at a state of readiness and are designed to be launched by the rapid remotely-controlled opening of the silo doors, without requiring any human action at the widely-dispersed launch areas.

It was intended originally to form three squadrons of SSBS missiles as the second-generation 'force de frappe', supplementing Mirage IVA strategic bombers of the French Air Force and with the French Navy's MSBS submarines to follow. Budget cutbacks compelled the deletion of one squadron. Deployment of the others started after the final S-02 prototype missile made a fully successful 1,550-mile (2,500km) flight towards the Azores, from a silo at Landes test centre on 24 June 1969. The first group became operational in the summer of 1971 and the second in 1972.

SSBS (S-3)

France



Surface-to-surface ballistic missile. Under development.

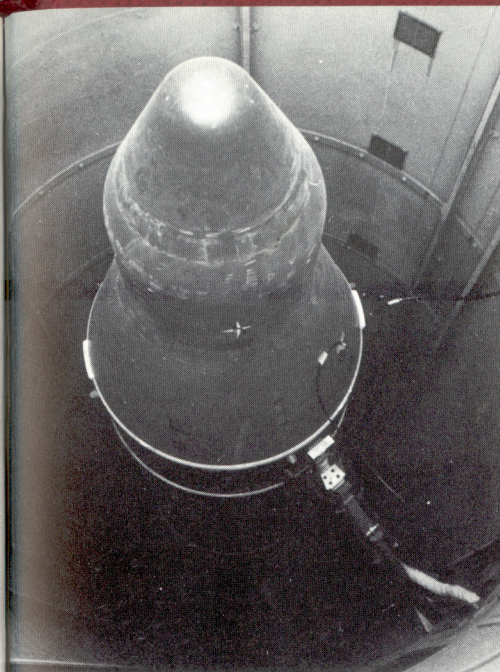
Prime contractor: Aérospatiale, Division des Systèmes Balistiques et Spatiaux
Powered by: First stage SEP P.16 (Type 902) solid-propellant motor
Second stage SEP P.6 (Rita II) solid-propellant motor
Guidance and Control: Inertial guidance system.
First stage has four gimbaled nozzles
Second stage has a single nozzle with freon injection for control.

Above: SSBS warhead on its transporter/loader.

Warhead: Thermonuclear, one megaton yield
Length: 45ft 0in (13.72m)
Body diameter: 4ft 11in (1.50m)
Launch weight: 56,880lb (25,800kg)
Range: 1,864 miles (3,000km)

Development and Service

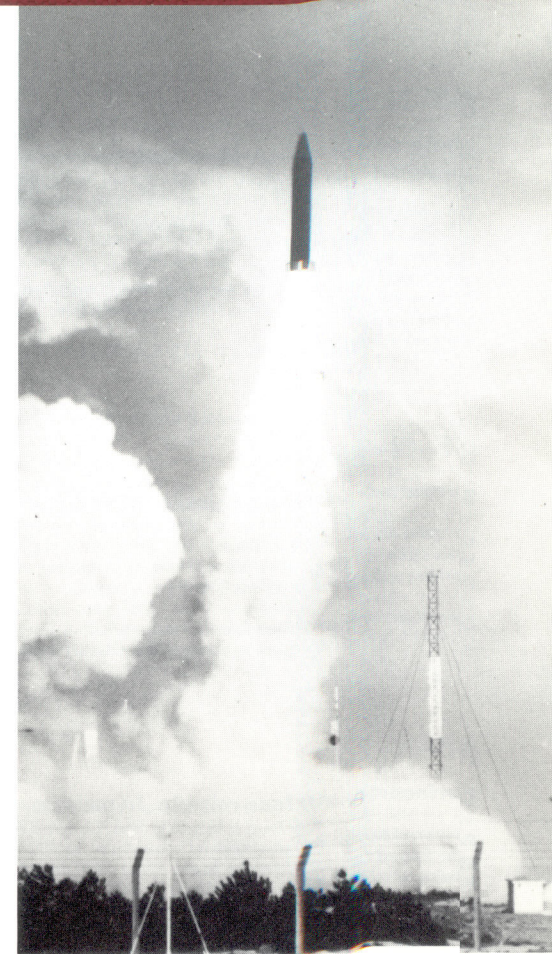
S-3 missiles will equip a new squadron of 9 silos in Haute Province, to be operational in 1980. The two



Above: SSBS in its silo.

Right: SSBS (S-3) launch.

S-2 squadrons will also be modernised to S-3 standard. The new missile will have improved penetration aids, as well as a thermonuclear warhead. The re-entry vehicle will be more advanced than that of the S-2, embodying subsystems to increase its resistance to ABM (anti-ballistic missile) nuclear attack.



SS-N-7

Underwater/surface-to-surface missile. In service.

Powered by: Solid-propellant rocket motor
Warhead: High-explosive
Max speed: Mach 1.5
Range: 35 miles (56km)

Development and Service

This short-range missile is carried by the 15 nuclear-powered submarines of the Soviet Navy's 'Charlie I and II' classes, each of which has eight launch-tubes. It may also be carried by the 'Papa' class submarine, each with 10 launch tubes. Estimated range of this missile, which does not yet have a NATO reporting name, is 35 miles (56km). It has been suggested that it can be underwater launched. SS-N-7 is thought to use autopilot control with active radar homing. Deployment began in 1968.

USSR

SS-N-8

USSR

Underwater-to-surface ballistic missile. In service.

Powered by: Liquid propellant motors
Airframe: Two-stage missile
Guidance: Stellar-inertial
Warhead: Single re-entry vehicle with 1-2 megaton yield or three MRVs. A three MIRVed version has been tested
Range: 4,800-5,700 miles (7,725-9,200km)

Development and Service

This liquid-propellant SLBM, first deployed in 1973, is carried on the 'Delta I and II' classes of nuclear powered submarines, each submarine carrying 12 and 16 tubes respectively. By 1979, 15 'Delta I' class and eight 'Delta II' class submarines had been built. The SS-N-8 has a range considerably greater than that of the new American Trident 1 missile and its warhead has a bigger yield. The Soviet Union currently has 950 SLBM launchers.

SS-N-11

USSR

Surface-to-surface missile. In service.

Length: approx 22ft (6.7m)
Max speed: High subsonic
Range: approx 43.5 miles (70km)

Development and Service

SS-N-11 is the designation given to the missile, in its

new launcher, carried on the Osa-2 patrol boats and a number of Soviet Kildin and Kashin class destroyers. It is also employed on the Indian Navy Vijaydurg corvettes, and Osa-2s of Iraq and Finland. Whether this is a new missile or an advanced version of 'Styx' is uncertain.

SS-N-12

USSR

Surface-to-surface missile. In service.

Powered by: Turbojet engine
Max speed: approx Mach 2.5
Range: approx 280 miles (450km) Could cruise at lesser speed for several times given range

Development and Service

Thought to have been developed as a replacement for 'Shaddock'. However, only the three Soviet aircraft carriers of the Kiev class are known to deploy the missile.

SS-N-13

USSR

Submarine-launched missile.

Guidance and Control: Cruise phase using satellite data. Terminal homing guidance
Warhead: Nuclear
Max speed: Mach 4

Development and Service

This missile could fit into the launch tubes of Soviet 'Yankee' class ballistic missile submarines. It may have been put into service as early as 1975. It has been suggested that its primary role is against ballistic missile submarines and aircraft carriers, but it clearly has other capabilities.

SS-N-14

USSR

Anti-submarine missile. In service.

Range: approx 18.5 miles (30km)

Development and Service

SS-N-14 is an anti-submarine weapon and serves on board the new Soviet Kara and Kresta II class cruisers, Krivak class destroyers, Kiev class aircraft

carriers and Moskva class helicopter cruisers. It is a winged missile, based around a homing torpedo or nuclear depth charge. Fired from a ship-borne container or launcher, the missile flies over the probable submarine location and releases its warhead into the water.

SS-N-15

USSR

Underwater-to-underwater missile. In service.

Warhead: Nuclear
Range: approx 25 miles (40km)

Development and Service

Similar in concept to the US Subroc, the SS-N-115 is thought to be carried by the Soviet 'Victor II' class fleet submarines, the extra length of these over the earlier 'Victor' class indicating installation of the necessary launching tubes.

SS-NX-17

USSR

Underwater-to-surface ballistic missile. Under development.

Powered by: Solid-propellant motors
Guidance: Inertial
Warhead: Single re-entry vehicle. Has MRV/MIRV capability
Length: approx 36ft 3in (11m)
Body diameter: approx 5ft 5in (1.65m)

Development and Service

The SS-NX-17 was the first of two new Soviet SLBMs to undergo trials in recent years and the first Soviet SLBM to be powered by solid propellant motors. Testing of the missile started in 1975, and trials were underway in 1978 on board a 'Yankee' class submarine, the class of submarine on which it is expected to replace SS-N-6s. The SS-NX-17 is also equipped with a post-boost vehicle which is compatible with MRV capability, although reports have indicated that early trials centred on a single re-entry vehicle warhead.

SS-NX-18

USSR

Underwater-to-surface ballistic missile. Under development.

Powered by: Liquid-propellant motors
Warhead: MIRV with two or three re-entry vehicles
Length: approx 46ft 3in (14.1m)
Body diameter: approx 6ft (1.83m)
Range: approx 5,900 miles (9,500km)

sophisticated guidance system than that in the SS-NX-17 and also has a post-boost vehicle for its MIRVed warhead. The first submarine launch of an SS-NX-18 took place in 1976. The missile is intended to replace SS-N-8s in 'Delta' class submarines and to equip the latest Soviet submarines of 'Delta III' and 'Typhoon' classes, of which many are being built.

Development and Service

Second of the new Soviet SLBMs, first test flown in 1975. It is believed to incorporate a more

Standard ARM (AGM-78 and RGM-66D)

USA

Air-to-surface and surface-to-surface anti-radiation missile. In production and service.

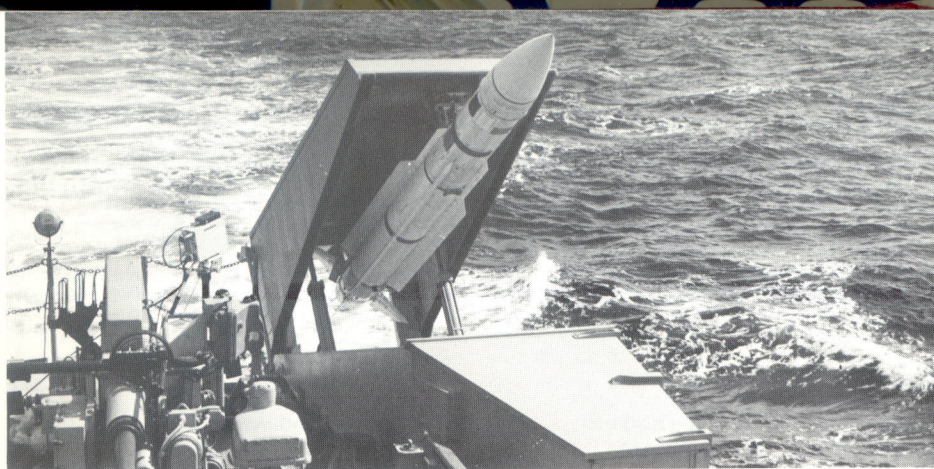
Prime contractor: General Dynamics Corporation, Pomona Division
Powered by: Aerojet-General Mk 27 Mod 4 dual-thrust solid-propellant rocket motor
Airframe: Cylindrical body with pointed ogival nose. Cruciform long-chord narrow-span wings, with forward portions of much reduced span, indexed in line with cruciform tail control surfaces
Guidance and Control: Passive homing guidance system, using seeker head which homes on enemy

radar emissions. Control by tail surfaces

Warhead: High-explosive
Length: 15ft 0in (4.57m)
Body diameter: 1ft 1.5in (0.343m)
Wing span: 3ft 6in (1.07m)
Launch weight: 1,356lb (615kg)
Max speed: Mach 2
Max range: 15.5 miles (25km)

Development and Service

Design studies for this anti-radiation development of the RIM-66A Standard Missile 1 were started in 1966. Flight trials followed in 1967 and the weapon entered full production in 1968. Its purpose is to



home on and destroy enemy defensive and missile guidance radars. This must be possible in an ECM environment, and with the knowledge that an enemy operator will switch off a radar the moment he suspects that its signals are being picked up and used to provide target data for attack. As a result, a key item of support equipment is the Target Identification and Acquisition System (TIAS) carried by aircraft used as launch vehicles for Standard ARM. This is able to compute a trajectory for the missile on the basis of data already monitored in the event of the target radar being switched off.

Standard ARM (anti-radiation missile) is carried by the US Navy's A-6B/E and USAF's F-105 and F-4G. The original AGM-78A version used a standard Texas Instruments seeker head, as fitted to the Shrike missile. This was followed by an improved seeker developed by Maxson Electronics on the AGM-78B. Further-improved versions have been developed, with a seeker by GD/Pomona, including the late production model designated AGM-78D. An impact marking device is fitted, to assist subsequent attacks on concealed targets.

The US Navy carried out firing trials of Standard ARM missiles from a special box-launcher mounted on a patrol gunboat during 1971, to evaluate the usefulness of the weapon system in a surface-to-surface role. This version remains in production and serves on guided missile destroyers and patrol combatant boats of the US Navy and vessels of foreign navies. The surface-to-surface version is designated RGM-66D. A truck-based coastal defence version of the RGM-66D has been produced.



Top: Standard ARM launcher on a US Navy gunboat.

Above: AGM-78D version of Standard ARM carried by an F-105 Thunderchief.

Standard Missile (RIM-66/RIM-67A)

Supersonic ship-launched surface-to-air missiles. In production and service.

Prime contractor: General Dynamics Corporation, Pomona Division

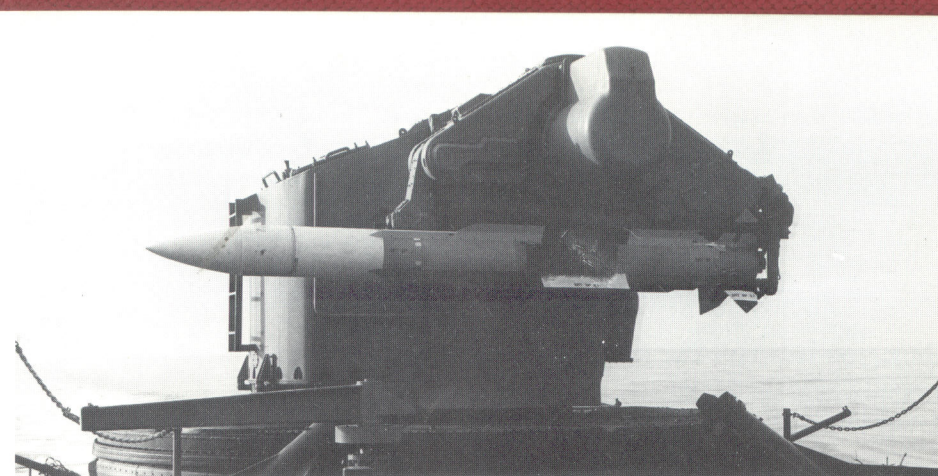
Powered by: RIM-66 dual-thrust solid-propellant rocket motor
RIM-67A tandem two-stage solid-propellant rocket motors

USA

All motors are produced by the Navy Ordnance System Command

Airframe: RIM-66A has cylindrical body with pointed ogival nose and cruciform long-chord narrow-span wings, with forward portions of much reduced span, indexed in line with cruciform tail control surfaces.

RIM-67A second stage is externally similar to RIM-66A; first stage comprises a cylindrical booster with cruciform tail-fins indexed in line with second stage surfaces.



Above: Standard Missile 1 on the guided missile destroyer USS Buchanan.

Right: First guided flight of a Standard Missile 2.

Guidance and Control: General Dynamics/Pomona semi-active radar homing guidance. Control by tail surfaces

Warhead: High-explosive, with impact and proximity fuses

Length: RIM-66A 15ft 0in (4.57m)

RIM-67A 27ft 0in (8.23m)

Body diameter: 1ft 1.5in (0.34m)

Wing span: RIM-66A 3ft 5.75in (1.07m)

RIM-67A 5ft 3in (1.57m)

Launch weight: RIM-66A 1,300lb (590kg)

RIM-67A 2,337lb (1,060kg)

Max speed: RIM-66A over Mach 2

RIM-67A over Mach 2.5

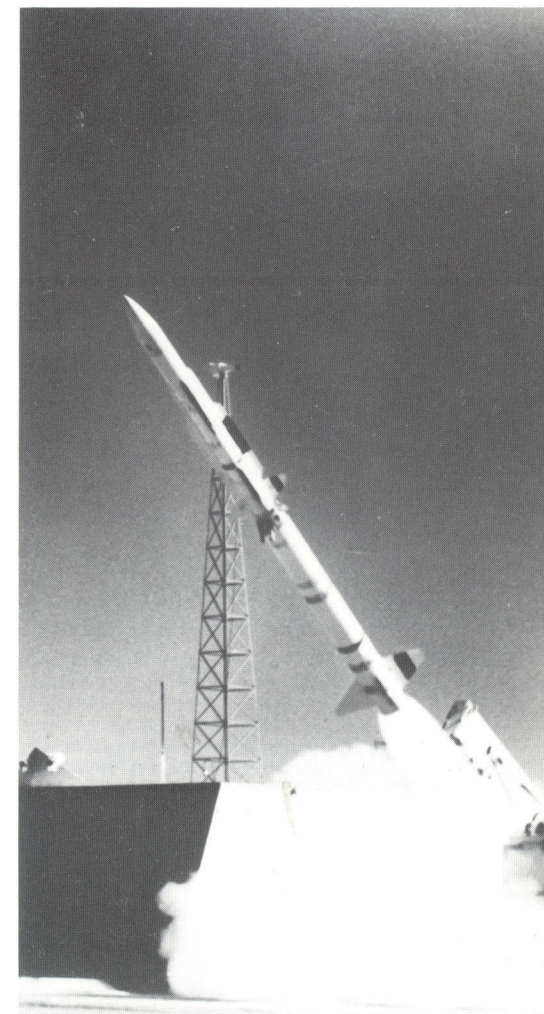
Max range: RIM-66A 12.5 miles (20km)

RIM-67A 35 miles (56km)

Effective ceiling: 65,500ft (20,000m)

Development and Service

These two ship-launched missiles were developed by General Dynamics to replace their Tartar and Advanced Terrier, which the new weapons resemble externally. Simplicity and reliability result from the switch to solid-state electronics and an all-electric control system, with no pneumatics or hydraulics. The two configurations, the original RIM-66A and improved RIM-66B with Mk 56 Mod 0 motor medium-range Standard Missile 1 (MR) and RIM-67A extended-range Standard Missile 1 with Mk 30 Mod 1 booster (ER), are intended for use on cruisers and destroyers (MR) and frigates (ER). They are effective against both aircraft and anti-ship cruise missiles, down to very low levels, and have a surface-to-surface capability. About 70 ships of the US Navy and of Italy, Japan and Spain have been fitted with Standard Missile 1. Deployment was originally scheduled for completion by the mid-1970s, but missiles were still being produced in 1978. Standard Missile also forms the basis of the Standard ARM anti-radiation missile system. It will also be used in the initial Aegis defence system as the improved RIM-66C Standard Missile 2 (SM-2)



(see Aegis). Again medium and extended-range versions are employed, with ranges of approximately 30 miles (48km) and 50 miles (80km) respectively. The SM-2 has a new semi-active monopulse terminal homing receiver, an inertial reference unit for mid-course guidance, a telemetry link for mid-course command guidance and a digital guidance

computer. The SM-2 may also replace Advanced Terrier missiles on the majority of US vessels carrying the latter under the CG/SM-2 programme. Improvement programmes are also being initiated to enable Standard Missile to deal with future threats, whether from high-altitude supersonic cruise missiles or in other forms.

Stinger (XFIM-92A) and Alternate Stinger

USA

Shoulder-fired surface-to-air missile. Ready for production.

Data: Stinger
Prime contractor: General Dynamics Corporation, Pomona Division
Powered by: Atlantic Research dual-thrust solid-propellant rocket motor
Guidance and Control: Initial optical aiming with infra-red terminal homing
Warhead: High-explosive, with proximity fuse
Length: 5ft 0in (1.52m)
Launch weight: 29lb (13.4kg)

Development and Service

Stinger is an advanced version of Redeye one-man shoulder-fired air defence missile, and was originally known as Redeye II. It has been developed to supersede the earlier missile. The first guided test flight took place in January 1974. Six firings against manoeuvring targets were successfully made in early 1975 and the engineering development phase of Stinger was completed the same year. A decision whether to put Stinger into production was put off in 1976 and had not been concluded by 1978. Meanwhile studies of a new seeker with infra-red and ultra-violet sensitive detectors have been initiated.

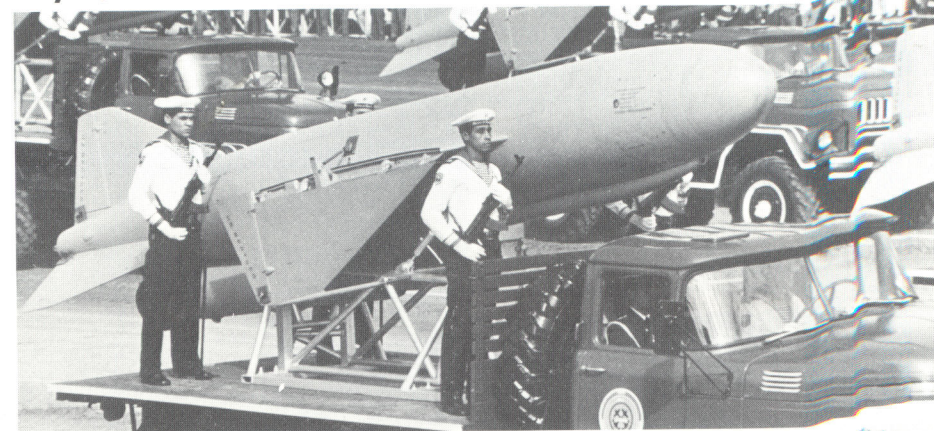
Stinger uses an advanced infra-red guidance system which enables the gunner to attack the target from almost any angle, and includes an IFF system. The missile is launched from the sealed disposable tube that acts as its shipping and handling container.

Under a \$5 million contract, a version known as Alternate Stinger, with a laser guidance system, is being developed by Ford Aerospace and Communications Corporation's Aeronutronic Division. In this case, the operator tracks the target by means of a lightweight stabilised sight that aligns the laser beam along which the missile travels to the target. Ten Alternate Stingers were initially produced. Between July 1975 and July 1976 firing trials of Alternate Stinger resulted in hits on a stationary and a low-flying aerial target.



Right: Stinger.

Styx (SS-N-2)



Right: 'Styx' launchers on a Komar class patrol boat.

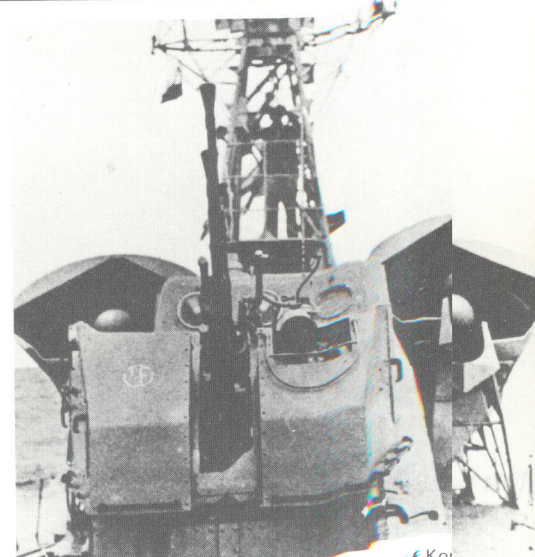
Surface-to-surface ship-launched cruise missile. In service.

Powered by: Nozzle for sustainer rocket motor in tail. Jettisonable solid-propellant booster, with downward-canted nozzle, under rear fuselage
Airframe: Aeroplane configuration. Circular-section body, with rounded nose-cone and tapered towards tail. Mid-set cropped-delta wings, with ailerons of almost full span. Three identical tail surfaces, each made up of a fixed fin and trailing-edge control surface
Guidance and Control: Cruise: Probably autopilot or radio command guidance
Terminal: Active radar system (sometimes reported as SS-N-2A and SS-N-2B versions respectively)
Control via ailerons and tail control surfaces
Warhead: High-explosive
Length: 20ft 6in (6.25m)
Max body diameter: 2ft 5.5in (0.75m)
Wing span: 9ft 0.25in (2.75m)
Launch weight: approx 6,615lb (3,000kg)
Max speed: approx Mach 0.9
Max range: 26 miles (42km)

Development and Service

This ship-to-ship weapon has the distinction of being one of the few modern surface-to-surface missiles of proven operational effectiveness. Its opportunity came on 21 October 1967, when the Israeli destroyer *Eilat* was detected sailing off Port Said, at a range of around 15 miles (24km). A series of 'Styx' missiles were launched from Soviet-built Osa class patrol boats of the Egyptian Navy, from the sheltered waters of the harbour. Some of these scored direct hits on the *Eilat*, which was sunk.

Each Osa class ship carries four 'Styx' missiles ready for launching in containers to each side of its rear deck. Komar class fast patrol boats are fitted with two similar containers. The Soviet Navy has a total of about 120 ships of the Osa class. Nearly as



many more Osa class and a similar number of Kor class ships are operated by the navies of Algeria, Bulgaria, China, Cuba, Egypt, East Germany, India, Indonesia, Iraq, North Korea, Poland, Romania, Somalia, Syria, Vietnam and Yugoslavia. In addition, 'Styx' missiles are built in China as CSS-1s in the form of patrol boats, frigates and destroyers. The Finnish experimental missile boat *Isku* carries four 'Styx' launchers, the Indian frigate *Talwar* carries two launchers and new North Korean boats carry the missile.

A more sophisticated version of 'Styx' is believed to be carried on board Osa 2 boats. These missiles are thought to be equipped with infra-red homing sensors to supplement the radar homing system. However, it has been reported that this missile is known in the West as SS-N-11 (qv).

Subroc (UUM-44A)

Underwater-to-underwater missile. In service.

Prime contractor: Goodyear Aerospace Corporation

Powered by: Thiokol solid-propellant tandem booster, with four nozzles embodying jet-deflection

Airframe: First stage comprises the Thiokol rocket motor in its cylindrical casing. The second stage is also cylindrical, with a short ogival nose-cone and four tail-fins, and is of smaller diameter than the first stage

Guidance and Control: Lightweight inertial guidance system. Control by thrust vectoring and aerodynamic tail-fins

Warhead: Nuclear depth bomb

Length: 20ft 6in (6.25m)

Max body diameter: 1ft 9in (0.533m)

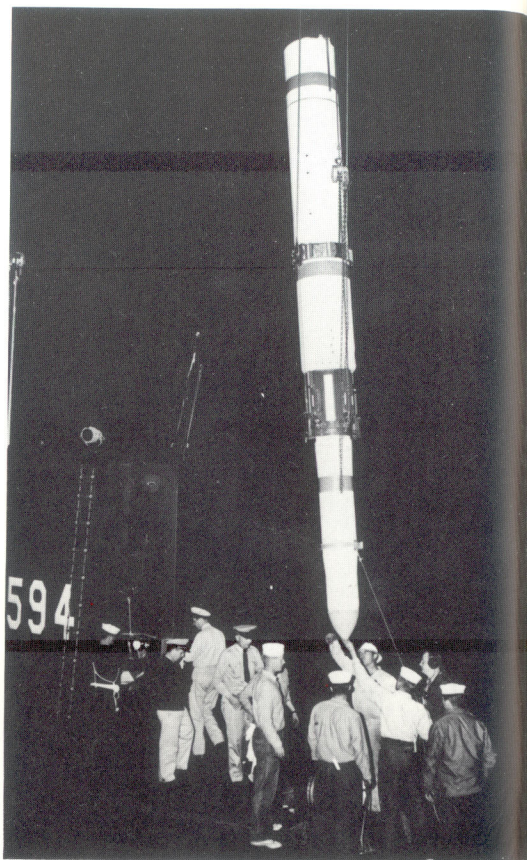
Launch weight: approx 4,085lb (1,853kg)

Range: 23-35 miles (40-56km)

Development and Service

Subroc is one of the most unusual missiles in service. Fired from the standard torpedo tube of a submerged submarine, it is designed to propel itself to the surface, then follow a ballistic trajectory to the predicted position of an enemy submarine, which it attacks with a nuclear depth bomb warhead. To make this possible, the large booster exhausts through thrust vectoring nozzles which enable the missile to change course underwater as well as in flight. The motor does not ignite until the missile has travelled a safe distance from its launch submarine, which need not be pointing towards the target. The Subroc is propelled upward and out of the water. Its inertial guidance system then directs it towards the enemy craft, whose position, course and speed have been computed and fed into the missile guidance before launch. At a pre-determined range, the booster is separated by thrust reversal and an explosive bolt disconnect system. The depth bomb continues in the ballistic trajectory, steered by its tail-fins in accordance with instructions from the inertial guidance system. This determines the position and angle of the missile as it re-enters the water. A special mitigating device cushions the shock of water entry at supersonic speed; the depth bomb then sinks and explodes.

Subroc became operational in 1965, after a highly successful series of full-range tests in the Pacific



Above: Loading a Subroc missile into a submarine.

from the USS *Plunger*. It continues to arm high-speed nuclear attack submarines of the US Navy in world-wide service. An improvement programme to maintain the effectiveness of Subroc was initiated in 1976.

USA

Super 530

Air-to-air missile. In production and service.

Prime contractor: SA Matra

Powered by: Thomson/Brandt butane-propellant rocket motor

Airframe: Cylindrical body with pointed ogival nose.

Cruciform long-chord, narrow-span wings, indexed in line with cruciform tail-surfaces

Guidance and Control: Dassault (EMD) Super AD-26 semi-active radar homing head

Warhead: Thomson/Brandt warhead, with proximity fuse

Length overall: 11ft 7.25in (3.54m)

Body diameter: 10.25in (0.26m)

France



Wing span: 2ft 1.25in (0.64m)

Fin span: 2ft 11.5in (0.90m)

Launch weight: 500lb (226kg)

Max speed: approx Mach 4.5

Range: approx 18.5-21.75 miles (30-35km)

Development and Service

This new missile arms Dassault Mirage F1 interceptors of the French Air Force and will eventually equip the Delta 2000. It is an all-weather and all-sector missile, with the capability of destroying targets flying in excess of 70,000ft (21,335m) and at high speed.

The first ramp-launched test of the Super 530 was conducted in January 1971. The first controlled

Top: Super 530s under the wings of an F1.

Above: Super 530 launch from an F1.

model was fired successfully in February 1973, and five complete missiles had been launched successfully against airborne targets by early 1975. The first firing from a Mirage F1 was made successfully in January 1976. The evaluation phase by the French Air Force is underway and Matra obtained good results during its last evaluation firings in 1978. Series production began in January 1979.

Super Falcon (AIM-4F/G)

USA

Air-to-air missile. In service.

Prime contractor: Hughes Aircraft Company
Powered by: Thiokol M46 two-stage solid-propellant motor, with first-stage rating of 6,000lb (2,720kg) st

Airframe: Cylindrical body, with cruciform long-chord delta wings, each extended at leading-edge root to form a narrow strake along the fore-part of the body. Cruciform tail control surfaces aft of wings. AIM-4F has ogival nose with central probe; AIM-4G has tapered nose with hemispherical glass tip

Guidance and Control: AIM-4F utilises Hughes semi-active radar homing guidance; AIM-4G uses infra-red homing system. Control by tail surfaces.

Warhead: High-explosive, weighing 40lb (18kg)

Length: AIM-4F 7ft 2in (2.18m)

AIM-4G 6ft 9in (2.06m)

Body diameter: 6.6in (0.17m)

Wing span: 2ft 0in (0.61m)

Launch weight: AIM-4F 150lb (68kg)

AIM-4G 145lb (65.7kg)

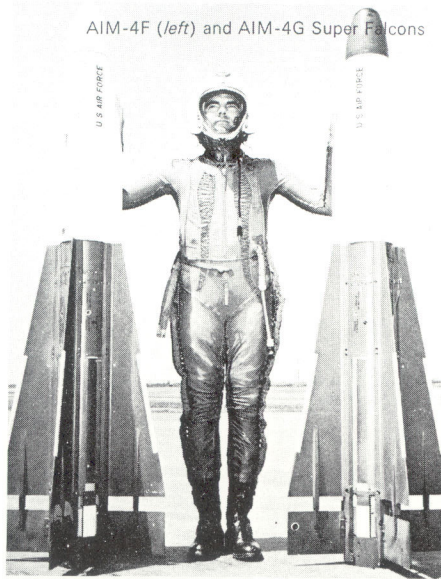
Max speed: Mach 2.5

Max range: 7 miles (11km)

Development and Service

Super Falcon was developed as an interim stage between the AIM-4A/C Falcon and the AIM-26 Falcon (see second edition *Missiles of the World*). First version, introduced in 1958, was the radar-homing AIM-4E (originally GAR-3), which was succeeded in 1960 by the improved AIM-4F (GAR-3A) after only 300 Es had been built. Simultaneously, Hughes introduced the AIM-4G (GAR-4A), with infra-red homing head, and a mixed

AIM-4F (left) and AIM-4G Super Falcons



Above: AIM-4F (left) and AIM-4G Super Falcons.

armament of four AIM-4F/Gs has since been standard in the internal weapons bay of USAF Convair F-106 Delta Dart interceptors. As well as having a higher performance than early Falcons, they are less susceptible to enemy countermeasures.

Swatter (AT-2)

USSR



Anti-tank missile. In service.

Powered by: Solid-propellant motor

Airframe: Cylindrical body with blunt rounded nose. Cruciform wings at rear, each with trailing-edge elevon. Tracking flare inboard of elevon on two wings. Two small movable foreplanes. Two motor nozzles on opposite sides of body between wings

Guidance and Control: Command guidance, possibly with infra-red terminal homing. Control via elevons, possibly supplemented by foreplanes during terminal homing

Warhead: Hollow charge

Length: 2ft 11.5in (0.90m)

Body diameter: 5.9in (0.15m)

Wing span: 2ft 2in (0.66m)

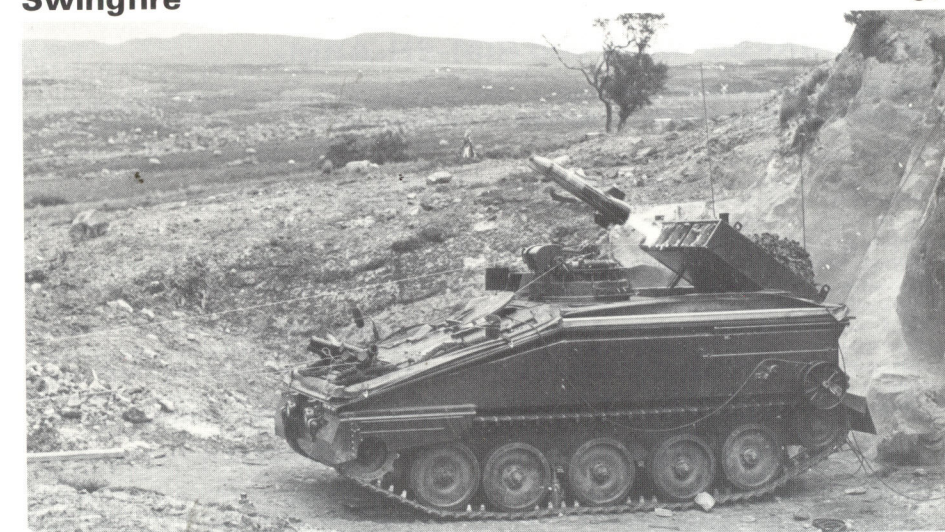
Launch weight: 55lb (25kg)

Cruising speed: 335 mph (540km/h)

Range: 985-7,220ft (300-2,200m)

Swingfire

UK



Long-range anti-tank missile. In production and service.

Data: Basic Swingfire

Prime contractor: British Aerospace Dynamics Group

Powered by: Solid-propellant rocket motor

Airframe: Cylindrical body, with ogival nose and spring-loaded cruciform wings which fold against the rear of the body while the missile is in its launcher

Guidance and Control: Wire-guidance by command signals transmitted by operator via joystick controller. Control by gimballed motor nozzle, known as a jetavator

Warhead: Hollow-charge high-explosive warhead, capable of destroying any known tank

Development and Service

This second-generation missile was first observed on a quadruple, retractable launcher carried by a BRDM vehicle, some years after 'Snapper' entered service. 'Swatter' is a more advanced weapon, and does not utilise wire guidance. This has facilitated its air-to-surface deployment on the twin launchers carried at the tips of the stub-wings of the Mil Mi-24 (NATO 'Hind-A and D') assault helicopter and probably on the Kamov Ka-25 (NATO 'Hormone'). However, this is thought to be an interim measure, until the AS-8 becomes available in sufficient numbers. In its surface-to-surface form, 'Swatter' is in service with the Warsaw Pact countries (except Bulgaria) and Egypt.

Above: Swingfire launch from a Striker reconnaissance combat vehicle.

Length: 3ft 8in (1.17m)

Body diameter: 6.7in (0.17m)

Wing span: 1ft 3.75in (0.40m)

Weight: 60lb (27kg)

Range: 500-13,125ft (150-4,000m)

Development and Service

Before the weapon activities of Fairey Engineering Ltd were transferred to British Aircraft Corporation (AT) Ltd, Fairey was working on a long-range command-guided anti-tank weapon known as Orange William. Features of this missile were incorporated in Swingfire, of which development

began in the early 1960s to replace the Malkara in British Army service. Its name reflects the fact that it has a firing arc of 90 degrees from a fixed launcher, enabling it to be launched around corners from a concealed vehicle. When mounted on a traversing turret, targets can be engaged through a full 360-degree field of fire.

The rocket motor is designed to impart a relatively low launch acceleration, making Swingfire sufficiently manoeuvrable to engage targets over a direct-fire range of under 500ft (150m). It is launched from its sealed disposable storage container, which can be mounted on a variety of vehicles, such as the FV 438 armoured personnel carrier, which carries two missiles ready to fire and 12 more stowed; the FV 712 Ferret Mk 5 scout car, which carries four ready to fire and four spares; and the British Army's Alvis Striker tracked reconnaissance combat vehicle. Regiments of the Royal Armoured Corps have been operational with Swingfire since 1969. The Belgian Army also uses the missile on its Striker vehicles. The Egyptian Army operates the

missile from Land Rovers carrying four-round pallets, and a production line is being established in Egypt under the terms of a licensing contract covering progressively increasing local assembly until 1985.

A new sighting and guidance station incorporating the electronics necessary for the launching and guidance of Swingfire missiles has now been developed. This enables Swingfire to be mounted on to any highly mobile lightweight vehicle, such as a Saboteur. This system is the light air transportable Swingfire which can be slung under a helicopter and dropped into the battlefield by parachute. Infantry transportable Swingfire comprises the new sighting and guidance station and a lightweight two-wheeled trolley which carries the missile and acts as the launcher. One man can move, deploy and operate the complete system.

Talos (RIM-8G-AAW and RIM-8H-ARM)

USA

Ship-launched surface-to-air and surface-to-surface missile. In service.

Prime contractor: The Bendix Corporation, Guidance Systems Division. Mishawaka Operation
Powered by: 40,000 hp Bendix 28in (710mm) ramjet sustainer and Allegany Ballistics tandem jettisonable solid-propellant booster

Airframe: Tandem two-stage missile. Cylindrical missile body, tapering toward nose air-intake which contains conical centre-body. Pivoted cruciform wings mid-way back on body and indexed in line with rectangular cruciform tail-fins. Cylindrical booster with four tail-fins indexed in line with fins of missile

Guidance and Control: Beam-riding, with terminal

semi-active radar homing. Control by pivoted wings
Warhead: Alternative nuclear or high-explosive, with proximity fuse

Length: 31ft 3.25in (9.53m) with booster
21ft 0in (6.40m) without booster

Body diameter: 2ft 6in (0.76m)

Wing span: 9ft 6in (2.90m)

Launch weight: 7,000lb (3,175kg)

Max speed: Mach 2.5

Max range: 70 miles (112km)

Development and Service

The effectiveness of this big ramjet-powered missile was demonstrated in 1968, when Talos missiles launched from the nuclear-powered cruiser *Long Beach* destroyed two MiG fighters flying over North

Vietnam, some 70 miles (112km) from the ship. Other US Navy cruisers continue to deploy Talos, and the designation RIM-8H-ARM given to one current version shows that it carries an anti-radiation homing head for surface-to-surface use against enemy radars at sea or on land.

Talos, like Terrier, was one of the first US surface-to-air missiles, tracing its development back to the

TAN-SAM

Surface-to-air missile. Under development?

Prime contractor: Tokyo Shibaura Electric Company

Powered by: Nissan solid-propellant rocket motor
Guidance and Control: Infra-red homing guidance system

Length: 8ft 10in (2.70m)

Body diameter: 7in (0.18m)

Launch weight: 220lb (100kg)

Max speed: Mach 2

Tartar (RIM-24)

Ship-based surface-to-air missile. In service.

Prime contractor: General Dynamics Corporation
Powered by: Aerojet-General dual-thrust solid-propellant rocket motor

Airframe: Cylindrical body with ogival nose, cruciform long-chord wings of constant narrow span and cruciform tail control surfaces immediately to rear of wings

Guidance and Control: General Dynamics semi-active radar homing. Control by tail surfaces

Warhead: High-explosive, with impact and proximity fuses

Length: 15ft 0in (4.57m)

Body diameter: 1ft 1.5in (0.34m)

Launch weight: 1,500lb (680kg)

Max speed: above Mach 2

Max range: over 10 miles (16km)

Development and Service

In general appearance Tartar resembles the second

Japan

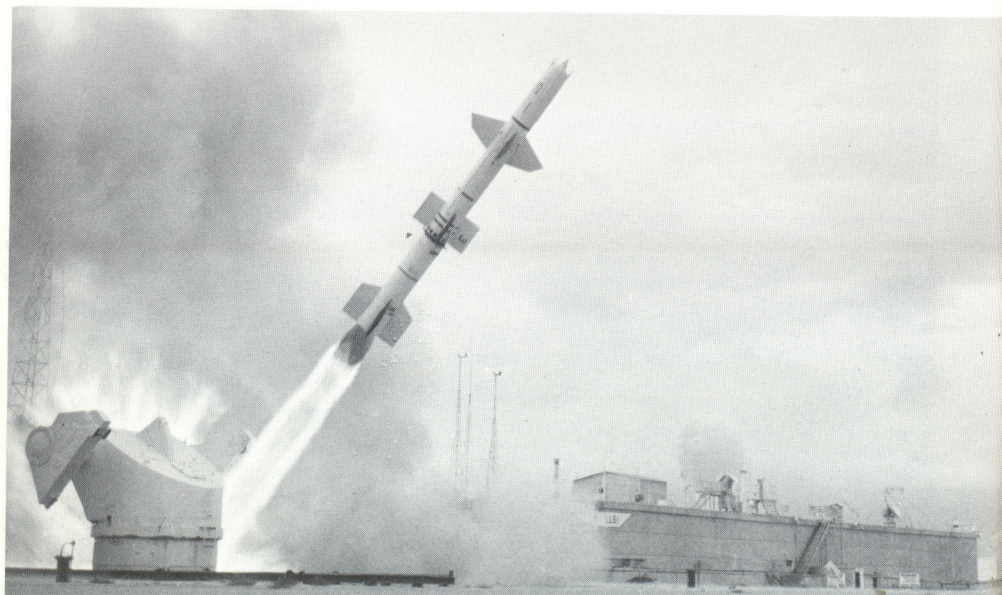
Development and Service

It has been reported that Tokyo Shibaura has developed a small air defence missile for the Japanese Army, intended to fill the defence gap between anti-aircraft guns and Hawk missiles. It is used in association with phased-array radar for target designation, acquisition and tracking. By 1978, approximately 17 prototype rounds had been launched. The JMSDF is also studying the missile. Production and deployment could possibly be underway.

USA

stage of the Advanced Terrier missile. It was developed by the Bureau of Naval Weapons, and produced by Convair Pomona, to provide a compact primary anti-aircraft defence for US Navy guided missile destroyers and guided missile frigates and secondary defence for guided missile cruisers. Full production began in 1960 and was completed in 1968, by which time Tartar equipped many US Navy ships, three Perth class Australian, four French Type 47 (now with Standard Missile), three West German Lütjens class, one Japanese Amatsukaze class and two Italian Impavido class (now with Standard Missile) destroyers. By 1979 about 33 US ships carried Tartar launchers and missiles. Tartar is being replaced by RIM-66 medium-range Standard Missile, which it resembles in appearance, and many other US ships deploy Tartar launchers and these newer missiles. Similar Tartar/Standard weapon systems are carried by other ships of Italy, Iran, Japan, the Netherlands and Spain.

Below: Tartar leaving the guided missile destroyer USS *Sampson*.



Terne Mk 8

Anti-submarine rocket depth-charge. In service.

Prime contractor: A/S Kongsberg Vaapenfabrikk
Powered by: Two concentric solid-propellant rocket motors

Airframe: Cylindrical body with cruciform tail-fins.

Ogival nose-cone, tapering to slim cylindrical tip
Guidance and Control: Sonar on ship determines range, bearing and depth of target before Terne is fired. No in-flight guidance

Warhead: High-explosive, weighing 110lb (50kg), with combined acoustic proximity, impact and time fuse

Length: 6ft 4.75in (1.95m)

Body diameter: 8in (0.203m)

Launch weight: 298lb (135kg)

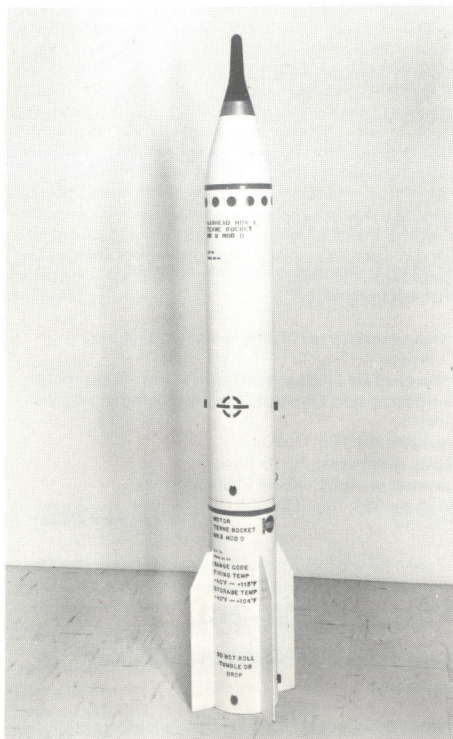
Performance: approx 1.9 miles (3km)

Development and Service

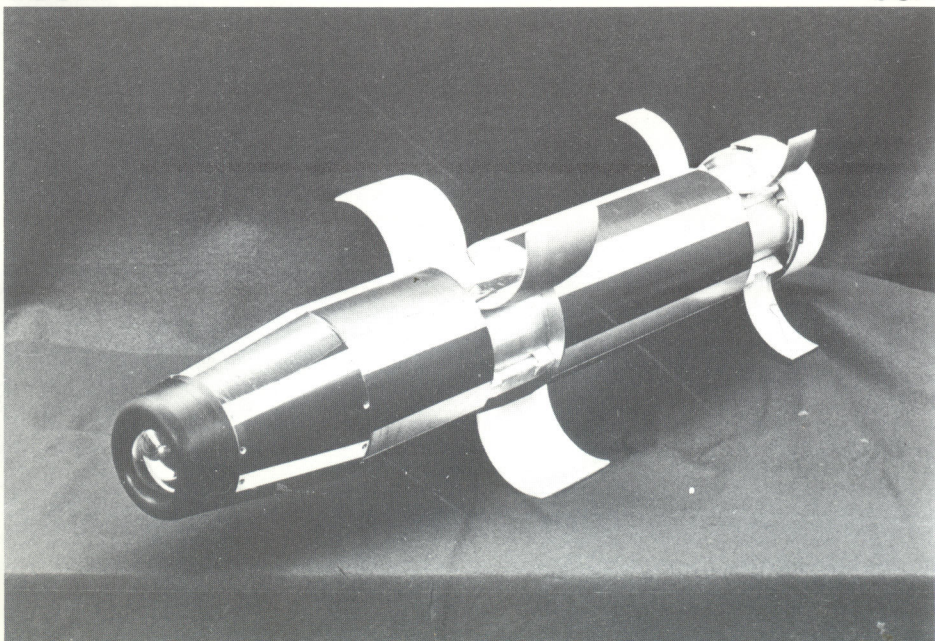
Operational on ships of the Royal Norwegian Navy, this rocket-propelled depth charge system can be installed on ships of any size down to small escort vessels. Once the ship's sonar has established the position of the enemy submarine, a full salvo of six Ternes can be fired in five seconds. The improved rocket motors of Terne Mk 8 give it about twice the range of the earlier Mk 7 version.

Right: Terne Mk 8.

Norway



TGSM

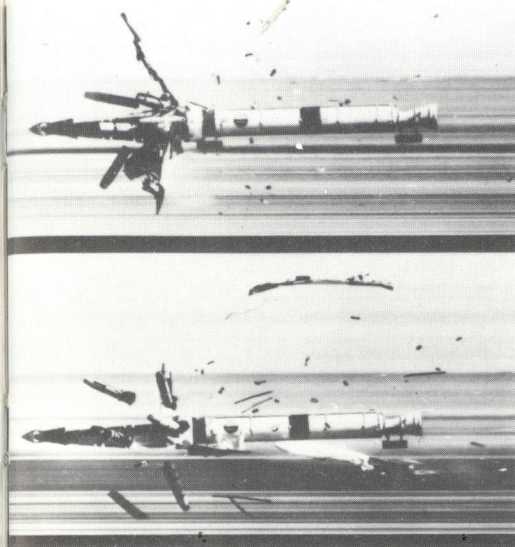


USA

Anti-tank missile system. Exploratory development.

Prime contractor: Vought Corporation, Michigan Division

Powered by: No propulsion in submissiles



Airframe: Cylindrical body, tapering towards nose. Cruciform wrap-around wings and movable tail surfaces

Guidance and Control: Each submissile has terminal homing and seeker. Control via tail surfaces

Warhead: Armour penetration

Length: 2ft 11in (0.89m)

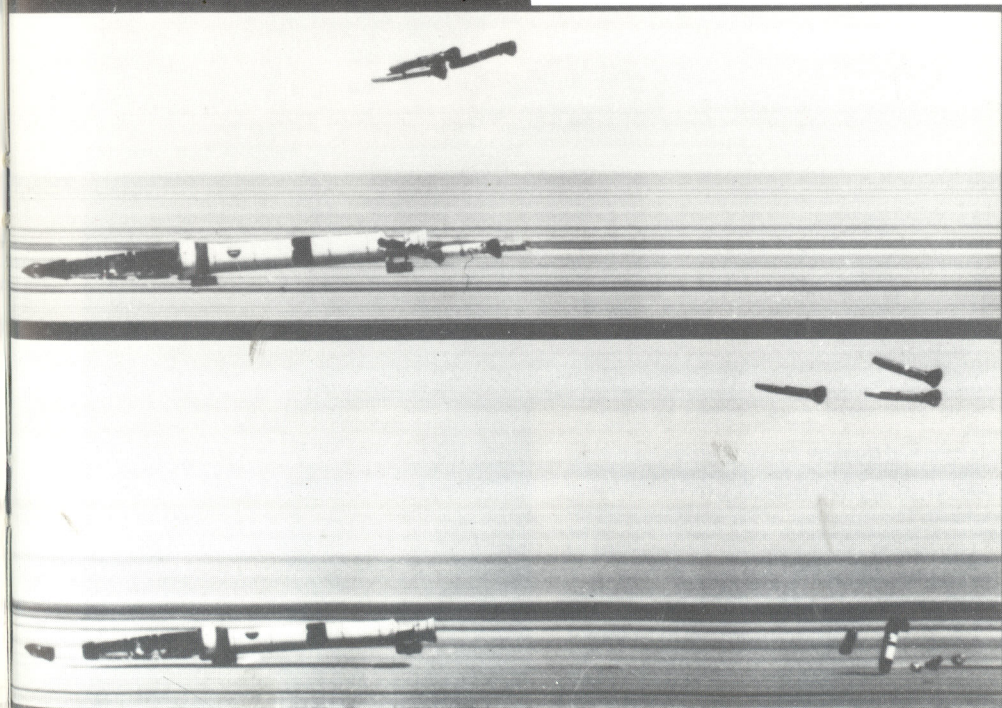
Body diameter: 6in (0.15m)

Weight: 35lb (15.9kg)

Development and Service

The Terminally-Guided SubMissile (TGSM) is a concept being investigated to achieve an effective indirect fire capability for destroying tanks. A dispensing rocket or missile is launched with a warhead containing the submissiles. An explosive charge breaks open the warhead skin and the airflow provides sufficient force to catapult the submissiles away from the delivery vehicle and disperse them over the target area. Each submissile has a balloon parachute system to decelerate, stabilise and orient it. Four tail-fins then open out and the balloon parachute is ejected. Each submissile has a guidance system and seeker which searches for a target. When a target is found, the submissile uses its movable tail surfaces to guide itself to target impact. Once launched, the missile system is independent of ground control. Components of TGSM have been tested on a subsystem basis.

Left & below: TGSM high-speed test to evaluate dispensing system.



Tigercat

Close-range surface-to-air missile system. In production and service.

Prime contractor: Short Brothers Ltd
Powered by: Two-stage solid-propellant rocket motor

Guidance and Control: Radio command with optical tracking. Radar tracking system for dark fire capability. Control via movable wings

Warhead: High-explosive with proximity fuse

Length: 4ft 10.25in (1.48m)

Body diameter: 7.5in (0.19m)

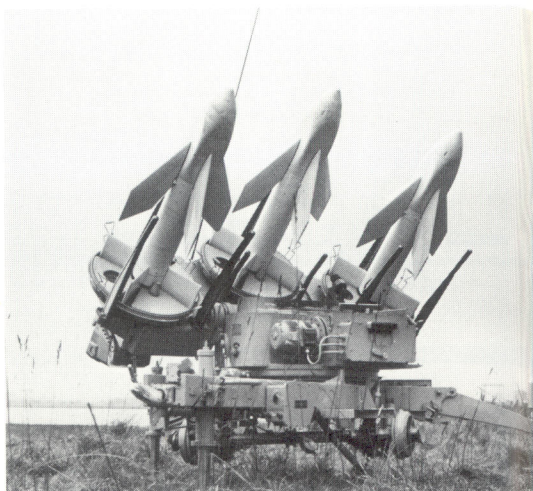
Launch weight: 132lb (60kg)

Range: over 15,580ft (4,750m)

Development and Service

This missile system was evolved specifically as an unsophisticated guided weapon with instant readiness for the point defence of airfields and other important potential target areas on land. The Tigercat missile is identical with Seacat (qv), which speeded development of the system, and it has been operational with the RAF Regiment since 1970. Other users include the Air Force of Iran, the Armies of Argentina, Jordan and Qatar, the Argentinian Marine Corps and India.

In its mobile form, Tigercat comprises a three-round launcher-trailer and a director trailer, housing the optical sighting and launch control equipment. They can be towed by two vehicles such as Land-Rovers, carrying the launch crew, additional missiles,



generator and other items. In operation, after the target has been acquired by the aimer and the missile fired, the aimer uses a thumb-operated controller to guide the missile along the line-of-sight to the target. By integrating Tigercat with a fire control radar such as the Marconi 850 or HSA Flycatcher both dark and blind fire can be added to the optical line-of-sight mode of operation.

UK

Titan II (LGM-25C)

Intercontinental ballistic missile. In service.

Prime contractor: Martin Marietta Corporation
Powered by: First stage Aerojet-General LR87-AJ-5 storable liquid-propellant engine rated at 430,000lb (195,000kg) thrust

Second stage Aerojet-General LR91-AJ-5 storable liquid-propellant engine rated at 100,000lb (45,360kg) thrust

Airframe: Two-stage missile. Cylindrical body of high-strength aluminium alloy, with constant diameter. Blunt-nosed conical warhead. No fins or wings

Guidance and Control: Inertial guidance system by AC Electronics. Control by two gimbaled nozzles on first stage and one on second stage

Warhead: Thermonuclear, in General Electric Mk 6 ablative re-entry vehicle

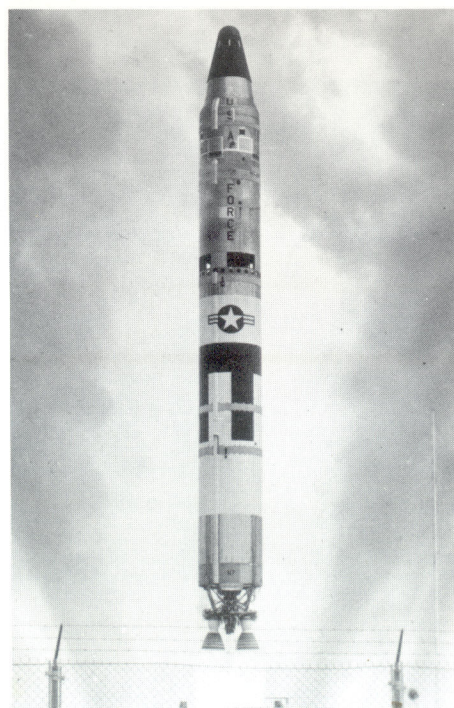
Length: 102ft 8.25in (31.30m)

Max body diameter: 10ft 0in (3.05m)

Launch weight: 330,000lb (149,690kg)

Max speed: 17,000mph (27,360km/h)

Max range: 9,320 miles (15,000km)



Right: Titan II launch.

USA

Development and Service

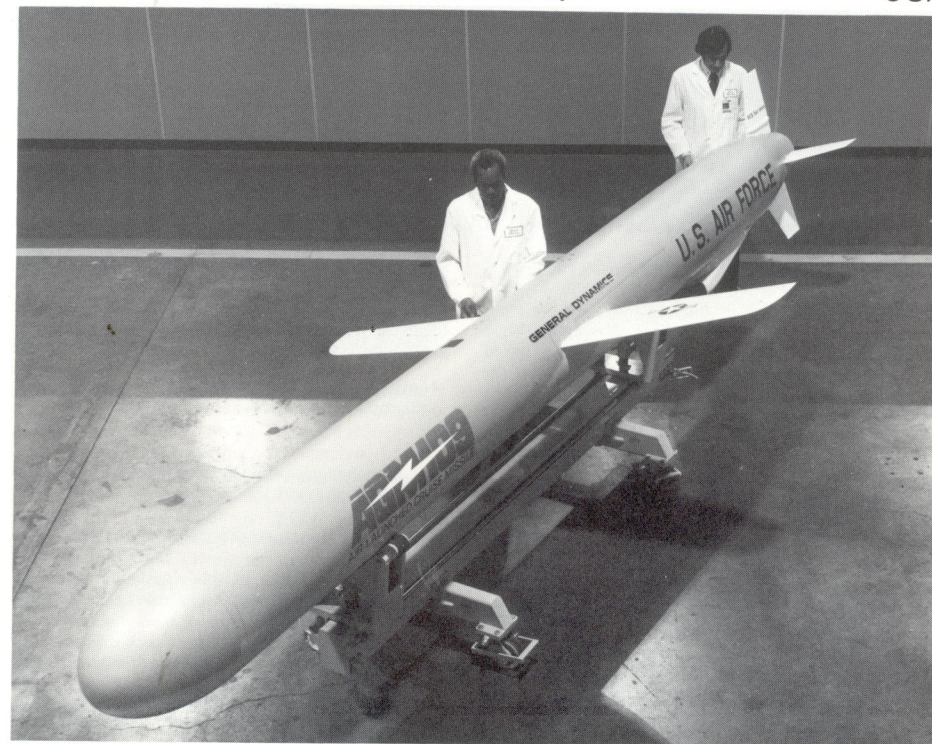
The USAF's Strategic Air Command deployed originally two huge liquid-propellant ICBMs, named Atlas and Titan. Titan I became operational in 1962 and was joined by Titan II in the following year. This was by far the most formidable of all America's first-generation long-range missiles. It could be stored in, and launched from, an underground silo, and carried the largest H-bomb warhead that has ever been fitted to a US missile. As a result, the USAF decided to retain six squadrons of Titan IIs, with a total of 54

missiles, although its original intention had been to withdraw all liquid-propellant ICBMs from service as the Minuteman force became operational.

The Titan IIs are based at Davis-Monthan AFB, Arizona, McConnell AFB, Kansas, and Little Rock AFB, Arkansas. The re-entry vehicle carried by each missile is so designed that its speed and trajectory are corrected by four small vernier rockets before it separates from the burned-out second stage. It carries advanced penetration aids to make detection and destruction by an ABM extremely difficult.

Tomahawk (AGM-109/BGM-109)

USA



Cruise missile. Under development.

Contractor: Convair Division of General Dynamics
Powered by: Williams Research Corporation F107-WR-400 turbofan engine, in 600lb (272kg) thrust class. Surface and submarine launched missiles have an Atlantic Research Corporation solid-propellant motor, in 7,000lb (3,175kg) thrust class, in tandem for boost and underwater steering

Airframe: Cylindrical torpedo-shape body made of aluminium, tapering at tail. Two narrow-chord wings approximately midway between nose and tail, which fold inside body when the missile is in its launch capsule and extend forward for cruising flight in the

Above: AGM-109 Tomahawk.

atmosphere. Cruciform folding tail surfaces indexed in line with wings. Ventral air intake for cruise engine

Guidance and Control: Inertial guidance, with terrain comparison (map-matching) system supplied by McDonnell Douglas Astronautics Company for land attack version. Modified Harpoon missile guidance for anti-ship version

Warhead: Nuclear or conventional

Length: 21ft (6.40m) with booster
 18ft 3in (5.56m) without booster

Body diameter: 1ft 9in (0.53m)

Wing span: 8ft 4in (2.54m)

Launch weight: approx 2,550lb (1,157kg)
Cruising speed: approx 550mph (885km/h)
Range: Land-attack over 1,555 miles (2,503km)
 Anti-ship over 280 miles (451km)

Development and Service

Known originally as the submarine-launched cruise missile (SLCM), Tomahawk is now being developed in both land attack and anti-ship forms, for launching from aircraft and surface installations as well as from submerged submarines. The US Navy BGM-109 version, as described in detail below, was the original version of Tomahawk, and in October 1978 made 35 flights comprising seven underwater launches, two surface launches and 26 air launches. From the BGM-109 were developed the AGM-109 air-launched cruise missile for the USAF's Strategic Air Command, developed to compete with Boeing's AGM-86B to arm B-52s, and Tactical Air Command's ground-launched cruise missile (GLCM), designed to increase its strike capability and give TAC improved nuclear and conventional armament. The land attack weapon is turbofan-powered, with a solid-propellant tandem rocket boost and nuclear warhead. Conversion to anti-ship role involves substitution of tactical guidance and a conventional warhead. Fuel tankage is much reduced in this variant. No booster is fitted to either type of weapon when it is to be air-launched.

Initial development contracts for the naval weapon were awarded to LTV and GD in January 1974. Main difference in approach by the competing companies was that LTV used a strong stainless steel airframe for its BGM-110, while GD designed its BGM-109 to be tube-launched from a high-strength steel capsule in underwater and surface roles. This enables the missile itself to be built for maximum flight performance instead of being penalised by the extra weight that is otherwise needed to survive underwater launch and handling. The BGM-109, in its capsule, is loaded into the submarine's torpedo tube for firing. The tube is then flooded and the missile (held dry in the capsule until the moment of firing) is pressurised. Using the submarine's fire control system, the missile is checked out and the guidance is aligned. Ejection from the torpedo tube, by the submarine's normal hydraulic system, leaves the missile's steel capsule momentarily inside the tube. A lanyard attached to the capsule is pulled as the missile clears the submarine, resulting in booster ignition; the empty capsule is then ejected from the ship. Underwater boost and steering for the missile are provided by the solid-propellant motor, with jet tab control. During this phase, the pressure within the missile 'breathes out' in scuba-dive fashion. When the missile breaks the surface of the water, its aerodynamic surfaces and turbofan inlet are deployed automatically and it transitions to cruising flight on the power of the turbofan. Tomahawk then flies to the target at high subsonic speed, at very low altitude, guided by the US Navy's TERCOM terrain comparison method, in which the missile's computer compares the terrain over which it travels with its preprogrammed path, recorded on a digital map.

Wind tunnel tests, vibration tests and checkout of the underwater launch and boost sequence, as well



Above: BGM-109 Tomahawk emerging from the sea under boost motor power.

as tests of flight vehicles, continued during 1975, using YBGM-109/110 development vehicles. On 13 February 1976, a YBGM-109 was first to demonstrate successfully an underwater launch and boost-to-glide sequence. On 17 March the US Navy announced its choice of this missile for continued development. The first air launch and test flight of a complete anti-ship Tomahawk took place in March 1976, and in June the first air launch and test flight of a fully-guided land attack missile was achieved. In February 1977 the first boost-to-cruise demonstration missile was launched from a truck, and in April an over-the-horizon anti-ship search mission was successfully flown. In June of the same year a Tomahawk anti-ship missile was launched successfully from an underwater torpedo tube to demonstrate boost flight and transition to turbofan engine flight and in February 1978 two land attack and anti-ship Tomahawks were fired from USS *Barb*, an operational nuclear attack submarine.

Requirements of the Tomahawk programme include low radar cross-section, minimum visual and infra-red signatures and ability to operate on heavy hydrocarbon fuel.

A series of 10 flight tests with the AGM-109 began in 1979. Similarly, testing of the GLCM was scheduled to begin in 1979, with early operational capability two years later.

TOW (BGM-71A)

USA



Heavy anti-tank missile. In production and service.

Prime contractor: Hughes Aircraft Company

Powered by: Hercules Inc K-41 solid-propellant motor, with two separate boost periods

Airframe: Cylindrical body, tapering to a rounded nose section of smaller diameter. Cruciform wings, mid-way back on body, are folded inside launch-tube and flick forward as missile leaves launcher. Cruciform narrow-chord tail control surfaces, indexed at 45 degrees to wings, flick open rearward at launch

Guidance and Control: Wire guidance. Automatic missile tracking and command via optical sight. Control by tail surfaces

Warhead: High-explosive shaped charge, weighing 8lb (3.6kg)

Length: 3ft 9.75in (1.18m)

Max body diameter: 5.9in (0.15m)

Wing span: 1ft 1.5in (0.34m)

Launch weight: 42lb (19kg)

Max speed: High subsonic

Range limits: 215-12,300ft (65-3,750m)

Development and Service

The TOW (Tube-launched Optically-tracked Wire guided) anti-tank weapon system was conceived for the US Army as a replacement for the 106mm recoilless rifle and Entac and SS.11 missiles. It consists of a glassfibre launch-tube, a tripod mounting, a traversing and sighting unit, an electronic package and the TOW missile in a shipping/launch container which forms an extension of the launch-tube. Weight of the complete system is about 175lb (79.4kg), but it can be broken down into four units for carriage by infantry. It can be mounted on wheeled or tracked vehicles, and the US Army



Above: TOW fired from a US Army lightweight Fighting Vehicle System (FVS).

operates it on armoured personnel carriers and jeeps.

The missile itself is never handled by the launch-crew, all electrical and mechanical connections being made automatically when its container is inserted in the launch-tube. The solid-propellant motor burns initially only long enough to propel TOW from the